Academic Programs

Annual Program Assessment Report: 2018-2019

School: School of Arts and Sciences

Department: Biology

Program: Biology BS

Department Chair: Dr. Margaret MacNeil

Department Assessment Coordinator: Dr. Ivica Arsov

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Completed by: Dr. Ivica Arsov and Dr. Lesley Emtage

Date Report Submitted: May 31, 2019

I. **Program Mission:** The Biology Department at York College strives to prepare our students as passionate and critical scientists and provide them with the opportunity to explore the science of life, within the tradition of the liberal arts. Our program will help them develop critical-thinking, problem-solving and technical skills necessary to succeed in a rapidly changing world as they pursue exciting careers in the biological sciences. We also believe that research is a cornerstone of active learning and our students will be provided with the opportunity to participate in various research activities throughout their studies. They will develop abilities to acquire and critically interpret relevant information from reliable sources, to formulate scientific arguments, to master important laboratory techniques and statistical methods used in modern research, and to engage and communicate with the scientific community. We also seek to develop a transformative, experiential learning environment which fosters multi- cultural and ethical values helping our students to become competent, competitive leaders who will have a great impact in the global scientific community. We offer two programs of study, Biology (B.S. and B.A) and Biotechnology (B.S). B.A. in Biology will allow students to get a Biology degree with a more extensive exposure to liberal arts than B.S. In addition, the Biology Department and Teacher Education Program together offer a Secondary Education Certification Program in Biology.

II. **ASSESSMENT ACTIVITIES:** Please complete the table below, add rows as needed.

Institutional Learning Outcomes (ILOs)	Program Goals	Program Level Student Learning Outcomes (PSLOs)	Course(s), Section(s), N=Sample Size	Measure[1] & Expected Level of Students' Achievement	Findings	Use of Results
Intellectual Discovery & Creativity: Demonstrate excellence in academic inquiry, creativity, research, collaboration and professional growth.	**Goal #_1** Students recognize the basic principles governing biological organisms and communities.	# 1.1 Students will be able to state fundamental information about biological systems (evolution/biological molecules/cells/organisms/biological communities)	Bio 201 Bio 202 Bio 300s Bio 400s N=175	Embedded multipart exam short answer questions, Multiple choice quizzes	Students failed to reach expected level of achievement	Changes needed: Yes Type of change: My Lab & Mastering Exercises, Bio 201 Lab Restructuring.
		# 1.2 Students will be able to explain the fundamental principles governing biological systems.	Bio 201 Bio 202 Bio 300s Bio 400s N=175	Embedded multipart exam short answer questions, Multiple choice quizzes	Students failed to reach expected level of achievement	Changes needed: Yes Type of change: My Lab & Mastering Exercises, Bio 201 Lab Restructuring.
		# 1.3 Students will be able to apply their knowledge to explain the reasons underlying the outcome of a biological process.	Bio 201 Bio 202 Bio 300s Bio 400s N=175	Embedded multipart exam short answer questions, Multiple choice quizzes	Students failed to reach expected level of achievement	Changes needed: Yes Type of change: My Lab & Mastering

[1] Direct measure is required; indirect measure is optional. E.g. Direct: Exams, assignments, presentations, etc. Indirect : Survey, focus groups, etc.

						Exercises, Bio 201 Lab Restructuring.
		# _1.4____ Students will be able to analyze information about biological systems and use it to predict the outcome of a manipulation of a system. Click here to enter text.	Bio 202 Bio 301 N=100	MyLab & Mastering Pearson interactive education system	Not Assessed	Changes needed: Choose an item. Type of change:
		# _1.5____ Students will be able to analyze data regarding a biological model to evaluate the plausibility of the model.	Bio 202 Bio 301 N=100	MyLab & Mastering Pearson interactive education system	Not Assessed	Changes needed: Choose an item. Type of change:
Integrity: **Demonstrate integrity as a central value in all aspects of their engagement including learning, research and service.**	**Goal #_2** Students recognize and are able to apply the scientific method.	# _2.1____ Students will be able to articulate their hypothesis or question. # _2.2____ Students will be able to make reasonable predictions based on a hypothesis or model. # _2.3____ Students will be able to explain and/or propose an experiment with appropriate controls to test a hypothesis or model. # _2.4____ Students will be able to relate the results of an experiment to their hypothesis and prediction.	Bio 201, Bio 300s Seminar 486-489 Bio 300s, Bio 400s Bio 201, Bio 300s Seminar 486-489 Bio 300s, Bio 400s	Oral Presentations Lab Report Oral Presentations Lab Report	Student reached expected level of proficiency (70% class average) Student reached expected level of proficiency (70% class average)	Changes needed: No Type of change: Changes needed: No Type of change: Click here to enter text.

<u>Self-Reflection & Accountability:</u> **Reflect on their learning, identify challenges, create a plan to meet the challenges, and improve decision-making.** **<u>Intentional Interactions:</u>** **Participate in productive and creative interactions among various groups.**	**Goal #_3** Students have basic technical laboratory skills to collect data and are able to analyze data using appropriate statistical methods where required.	# _3.1____ Students will have the ability to perform basic technical laboratory skills. # _3.2____ Students will be able to use appropriate common statistical methods to analyze data, including measures of significance. # _3.3____ Students will be able to use common methods of presenting data, such as graphs or data tables, and interpret them.	Bio 300s, Bio 400s Bio 300s, Bio 400s Bio 300s, Bio 400s	Lab Report Lab Report Lab Report	Student reached expected level of proficiency (70% class average) Student reached expected level of proficiency (70% class average) Student reached expected level of proficiency (70% class average)	Changes needed: No Type of change: Changes needed: No Changes needed: No

III. **Data Collection and Analysis:** Based on the information above, what do the findings suggest? Describe how and when the data was collected and analyzed for each of the student learning outcome. Describe what tools were used to evaluate student work, e.g. rubrics. **Please attach rubrics used and identify level (program/course embedded)**. Describe how interrater reliability was established, including number of faculty involved in the processes.

In the Fall semester, Biology faculty members met to discuss departmental needs and assessment strategies. We agreed that our main goal would be to extend our assessment to students at different points during the course of their degree, and that we would focus on student's understanding of the fundamental topic of genetics. The Biology faculty also prioritized further data collection in order to clarify the interpretation of data collected from the Principles of Biology I in Spring 2017.

In order to clarify the results from our Spring 2017 assessment, Dr. Beaton designed a set of questions for the Principles of Biology I. To differentiate between student understanding of the principles of evolution and student's ability to analyze written texts, Dr. Beaton used multiple choice questions on the topic of evolution. The questions varied the amount of explanatory text but maintained a common Bloom's level (knowledge/comprehension).

BIO 201 Exam Assessment Questions

All are knowledge-based questions on the same topic:

1. **Whenever diploid populations are in Hardy-Weinberg equilibrium at a particular locus, _____.**

A) the allele's frequency should not change from one generation to the next
B) natural selection, gene flow, and genetic drift are acting equally to change an allele's frequency
C) two alleles are present in equal proportions
D) individuals within the population are evolving

2. **How many of these statements regarding populations are true?**

1. Mature males and females of a population can interbreed with each other.
2. Populations are sometimes geographically isolated from other populations.
3. Biological species are made up of populations.
4. Members of a population tend to be genetically more similar to each other than to members of other populations.
5. Populations have genomes, but not gene pools.

A) Only one of these statements is true.
B) Two of these statements are true.
C) Three of these statements are true.
D) Four of these statements are true.
E) All five of these statements are true.

3. **A large population of laboratory animals has been allowed to breed randomly for a number of generations. After several generations, 25% of the animals display a recessive trait (*aa*), the same percentage as at the beginning of the breeding program. The rest of the animals show the dominant phenotype, with heterozygotes indistinguishable from the homozygous dominants.**

   What is the most reasonable conclusion that can be drawn from the fact that the frequency of the recessive trait (*aa*) has not changed over time?

   A) The population is undergoing genetic drift.

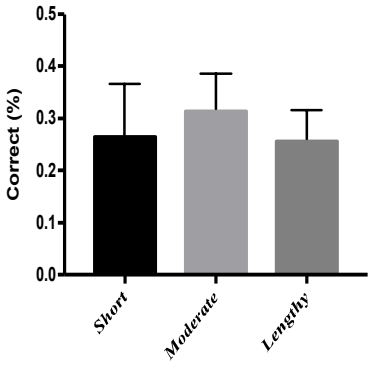
   B) The two phenotypes are about equally adaptive under laboratory conditions.

   C) The genotype *AA* is lethal.

   D) There has been a high rate of mutation of allele *A* to allele *a*.

   E) There has been sexual selection favoring allele *a*.

Dr. Emtage has completed the data analysis, and Drs. Emtage and Beaton have interpreted the results shown in Figure 1. We expected student performance to decrease with question length; the lack of impact of question length suggests that basic reading comprehension is not a dominant factor in their performance. Additionally, we expected that the fraction of students who were able to correctly answer the short question on evolution would be similar to the fraction of students able to answer questions on other topics, and thus to the average score (overall average score on the final was 54 ± 4%, N = 162). These expectations were not met. The results confirm that the students in Principles of Biology I need to acquire more effective study and review skills.



The Biology AAC is interested in comparing the performance of students as they progress through the Biology curriculum. We developed two strategies for comparing student performance at different levels. First, we developed a common set of exam questions that could a be given to students at different points in the curriculum. Second, we devised a grading spreadsheet appropriate for the majority of written lab reports assigned across the curriculum, which we can use to track student performance at different levels. The data shown here is organized according to learning Goal and Student Learning Objective (SLO). A common set of exam questions required a direct and unambiguous answers no interrater reliability or calibration was necessary. For written lab reports, several instructors involved in the assessment calibrated their grading using two student reports.

Goal 1: Students recognize the basic principles governing biological organisms and communities.

We chose to compare student's comprehension and analytical skills using questions on classical and molecular genetics, as we offer multiple courses with units on genetics at various academic levels. Drs. Emtage, Alter, and Arsov designed a multipart question to evaluate the students' knowledge and understanding of fundamental molecular genetics, and their ability to use the principles of classical and

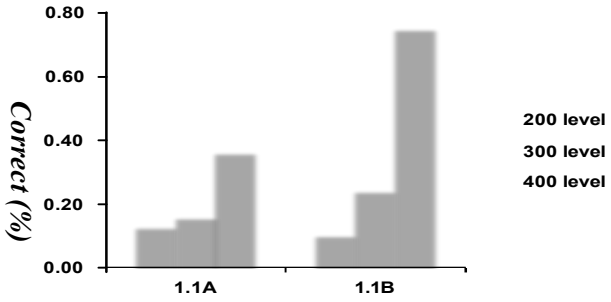
molecular genetics to analyze an inheritance pattern. Data was collected in the Fall semester, and then again in the Spring semester. The courses were at the freshman (Bio 202), sophomore (Bio 301, Bio 320), and upper-level (Bio 452, Bio 444). Each professor was responsible for grading the questions in his or her section. Dr. Emtage has collected these data and completed an analysis.

PSLO 1.1 Students will be able to state fundamental information about biological systems (evolution/biological molecules/cells/organisms/biological communities).

We have incorporated two fundamental knowledge questions (A and B) on the topic of molecular genetics into classes at several levels (Figure 2).

(A) Both the INS gene and insulin are polymers. What are the monomers and what is the polymer that make up the INS gene? What is the name of the monomers and polymer that make up insulin?

(B) How many copies of the INS gene are found in pancreatic beta cells? How many copies are found in other cell types, for example, cardiac muscle cells?



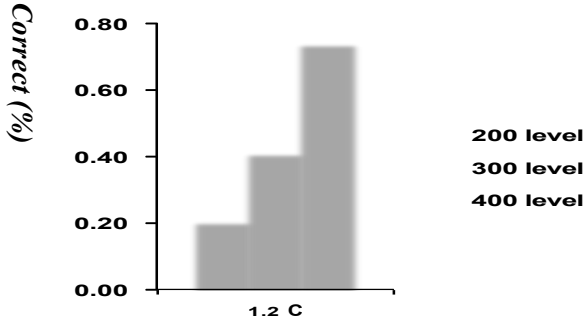


Figure 3. Assessment of PSLO 1.2 based on Molecular Genetics Questions C (see below) in three different Biology classes.

Data were collected and compared from a freshman level course (Bio 202, n=197), two sophomore level courses (Bio 301, Bio 320; n=43), and two upper-level courses (Bio 444 and Bio 452; n=30). As we expected, the students' performance improved significantly as they progressed through the Biology program. However, the performance of our seniors on the first question did not meet our expectation that at least two-thirds of seniors should be able to answer basic knowledge questions correctly.

PSLO 1.2: Students will be able to explain the fundamental principles governing biological systems.1. The students were assessed on their knowledge of the principle of differential gene expression (Figure 3, Question C). A question on differential expression was inserted into a freshman level course (Bio 202), two sophomore level courses (Bio 301, Bio 320), and two upper-level courses (Bio 444 and Bio 452).

(C) Is mRNA for insulin produced in equal amounts in pancreatic beta cells and cardiac muscle cells? Why or why not?

As we expected, the students' performance improved significantly as they progressed through the Biology program. The performance of our seniors is in line with our expectations that at least two-thirds would be able to answer these questions correctly.

PSLO 1.3: Students will be able to apply their knowledge to explain the reasons underlying the outcome of a biological process.

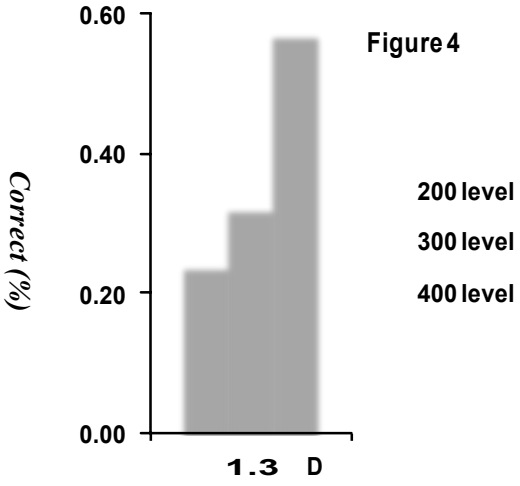


Figure 4. Assessment of PSLO 1.3 based on Molecular Genetics Question D (see text) in three different Biology classes.

Students ability to analyze genetic information and outcomes based on the principles of inheritance were tested by the last (Question D) of our molecular genetics questions.

D) Diabetes mellitus can be caused by a dominant mutation in the *INS* gene, *INS**C96Y. A healthy mother has an affected child. Give the genotype of the child at the *INS* locus, indicating the paternally and maternally inherited alleles.

The question was inserted into a freshman level course (Bio 202, n=197), two sophomore level courses (Bio 301, Bio 320; n=43), and two upper-level courses (Bio444 and Bio 452; n=30).

As we expected, the students' performance improved as they progressed through the Biology program (Figure 4). The performance of our seniors met our expectations that at least half should be able to answer an application/evaluation correctly.

Goals, 2-4: In brief, students will learn to use the scientific method, and to analyze and present experimental results.

Our final goal for the 2018-19 AY was to develop a method for the assessment of SLOs pertinent to experimental design and communication across multiple course levels, and to pilot the use of a department-wide rubric for assessing lab reports. Dr. Emtage, working with Dr. Beaton and Wenying Huang-Stolte, created and distributed a grading spreadsheet that can be used to directly assess eight (8) SLOs pertaining to experimental design and communication in laboratory instruction and learning. The grading spreadsheet can be customized according to the needs of individual assignments without affecting it's usage for departmental SLO assessment (Figure 5). Dr. Emtage also wrote a rubric to encourage the process of unifying lab report grading practices across the department. These materials were distributed to Biology Department faculty in order to collect pilot data, as well as feedback from other faculty. Pilot data was collected from Bio 320 and Bio 403.

PSLOs 2.1-2.3, 3.1-3.2, 4.1-4.3. *Student Learning Objectives related to Goals #2, #3 and #4:* Students recognize and are able to apply the scientific method, Students have basic technical laboratory skills to collect data and are able to analyze data using appropriate statistical methods where required, Students are able to communicate ideas and data in writing, including in standard scientific format.

During the Fall 2018 semester, we have conducted a more detailed lab report spreadsheet assessments in sophomore and upper-level classes, Bio 301, Bio 334 and Bio 452. The lab reports were graded using a grading spreadsheet (Figure 5) and rubric that can be used to assess multiple PSLOs.

	Bio 301	Bio 334	Bio 452
Title			
Describes lab content concisely, adequately, appropriately	**1.00**	**0.94**	**0.74**
Abstract			
Conveys a sense of the full report concisely and effectively	0.78	N/A	0.83
Introduction			
Successfully establishes the scientific concept of the lab	0.78	0.30	0.84
Effectively presents the objectives and purpose of the lab	0.76	0.98	0.85
States hypothesis and provides logical reasoning for it	0.62	0.64	0.85
MEAN	**0.72**	**0.64**	**0.85**
Methods			
Gives enough details to allow for replication of procedure	**0.68**	**0.89**	**0.86**
R esults			
Opens with effective statement of overall findings	0.70	0.79	
Format of tables and figures is correct	0.62	0.86	0.84
Accurately measures and analyzes data for lab findings	0.63	0.83	0.85
Presents verbal findings clearly and with sufficient support	0.64	0.85	0.84
MEAN	**0.65**	**0.83**	**0.84**
D iscussion			
Opens with statement of support/non-support of hypothesis	0.62	0.97	0.87
Backs up statement with reference to appropriate findings	0.63	0.87	0.81
Provides sufficient and logical explanation for the statement	0.60	0.86	0.81
Sufficiently addresses other issues pertinent to lab	0.62	0.91	0.81
MEAN	**0.62**	**0.90**	**0.82**
Conclusion			
Convincingly describes what has been learned in the lab	**0.68**	**0.89**	**0.84**
Presentation			
Citations and references adhere to proper format	0.70	0.87	0.84
References are reliable and appropriate	0.72	0.88	0.94
Report is written in scientific style: clear and to the point	0.61	0.87	0.86
Grammar and spelling are correct	0.78	0.88	0.82
MEAN	**0.70**	**0.88**	**0.87**
Overall aims of the report: the student...			
Has successfully learned what the lab is designed to teach	0.73	0.90	**N T**
Demonstrates clear and thoughtful scientific inquiry	0.70	0.81	**N T**
MEAN	**0.72**	**0.85**	

Figure 5. Spreadsheet used to assess PSLOs 2, 3 and 4, based on lab reports. The assessment measures pertinent to these SLOs are highlighted in red in the final column. This spreadsheet has been piloted in four different Biology classes to date.

The sample size was 15 for each course and the total number of reports assessed was 45. Again, our data confirms the pilot conducted in the 2018 Spring and indicated satisfactory progress on the

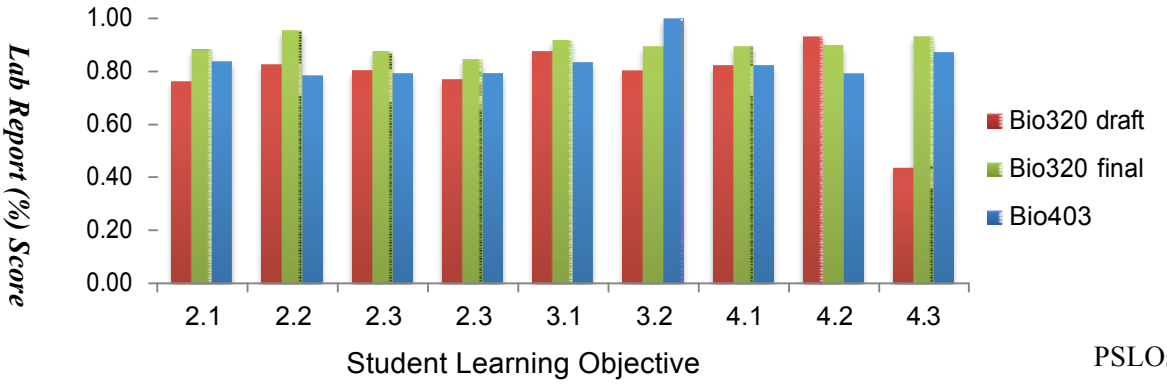


Figure 6. Assessment of PSLOs 2, 3 and 4 based on Lab Report spreasheet in two different Biology classes.

PSLOs assessed. Also, a clear trend of improvement was observed between sophomore and upper-level classes in all assessed categories. Our data indicate that mid- and upper-level students are performing satisfactorily on these SLOs (Figure 6).

We have assessed PSLOs 1.1-1.3 using questions A-D (explained previously in this Report) in the most recent cohort of Bio 202 (n=52) and Bio 301 (n=49) students in the Spring semester of 2019. The questions were implemented as bonus questions in their final exams. The number of students who attempted to answer the questions was higher in Bio 301 than in Bio 202 (30 vs. 15, respectively). However, the number of total correct answers were similar in both classes (26 in Bio 301 vs. 23 in Bio 202). Interestigly, the number of correct answers to Question A (biological polimers, covered in Bio 202) was higher in Bio 202 class, while Bio 301 was better in answering Question C (tissue-specific gene expression). Most likely this suggests that the students fared better if the material was covered more recently or in more detail. One strategy to improve the results, especially in more advanced Bio 301 class, is to assess and reinforce the most critical concepts from Bio 202 in the Bio 301 class. This could probably be achieved using Pierson's MyLab & Mastering exercises.

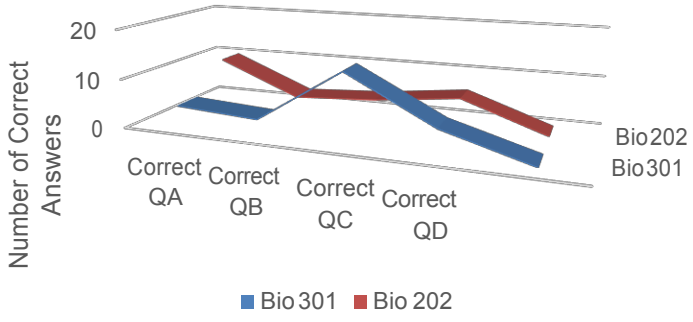


Figure 7. Assessment of PSLO 1.1-1.3 in Bio 202 and Bio 301 using Molecular Genetics questions A-D.

In addition, ***PSLOs 2.1-2.3, 3.1-3.2, 4.1, and 4.3*** have also been assessed again in Spring 2019 in three different 400-level courses**.** The results indicate that students in all three classeses achived the expected level of proficiency.

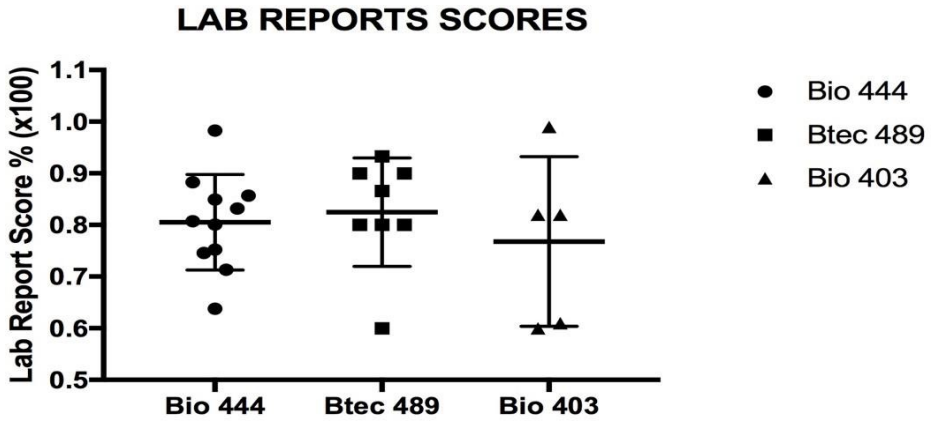


Figure 8. Assessment of PSLOs 2.1-2.3, 3.1-3.2, 4.1 and 4.3 based on Lab Report spreasheet in three different Biology classes.

IV. **Action Plan:** Based on the information provided above in *Use of Results* section, describe the next steps that will be taken to ensure that the changes indicated above are actually implemented. If no changes are needed, explain why.

Evaluation of student performance in BIO 201 made clear that most students were not learning the material, a conclusion supported by course grades. Our initial hypothesis, that perhaps poor performance was a result of poor reading comprehension, was not borne out by further study. Discussions with the many faculty teaching the lecture and lab sections led to the conclusion that many students are unprepared for university level course work in the sciences. In response to this problem, we proposed three courses of action; (1) that General Biology classes, including Bio 201, 202 and 301 facilitate and expand the use of Pierson's MyLab & Mastering Exercises (2) that Biology offer a student development class, BIO 111, that would teach basic study skills and college success strategies, while simultaneously introducing students to potential career paths, and (3) that the BIO 201 lab be revised to coincide with the material covered in the lecture portion of the course and include exercises designed to develop quantitative and analytical skills. Our approach continues to evolve and we are currently considering the possibility of incorporating the skills taught in the proposed BIO 111 course into the BIO 201 lab as part of the revision. If this proves feasible, we may pilot the revised lab with and without the study skills exercises to evaluate their efficacy. This new, revised Bio 201 schedule is shown bellow.

Revised BIO 201 Lab Schedule with Study Skills Exercises

Week	Lab title	**Skills Topic**
1	**Research Integrity** Initial skill assessment exercise Lab Safety Sexual selection in guppies simulation – HHMI Virtual Bio Lab	Adjusting to college
2	**Hardy-Weinberg Simulation – HHMI Virtual Bio Lab**	Organization
3	**Fast Plants Experiment (experimental design and establishment)**	Lectures
4	**Fast Plants Experiment (data collection)**	Reading
5	**Fast Plants Experiment (presentations)**	Learning
6	**Data analysis: Effects of multiple invasive species in experimental aquatic communities**	Learning Styles
7	**Animal behavior (Pearson) Taxis in brine shrimp, kinesis in pill bugs, agonistic display in Male Siamese fighting fish, reproductive behavior in fruit flies**	Writing
8	**Data analysis: Effect of bison grazing on species diversity in a tall grass prairie**	College Resources
9	**Decomposition and Soil CO_2 Emissions**	College Life
10	**Decomposition and Soil CO_2 Emissions**	Planning for the Future
11	**Data analysis: Forest ecosystem responses to chronic nitrogen additions**	
12	**Independent study projects**	
13	**Independent study projects**	
14	**Independent study projects**	

V. **Communication:** Indicate to whom, how and when the assessment results will be (or have been) communicated to internal and external stakeholders.

The assessment results will be communicated with internal stakeholders during regular departmental meetings and with external stakeholders via Academic Program Review.

VI. **Changes Implemented:** Describe any changes implemented as a result of assessment activities completed in the previous assessment cycle to "close the loop". Indicate the semester in which the change was implemented and when it will be reassessed. *(Use last assessment report submitted to obtain information on what changes were recommend in the previous report).*

Based on the poor results in the assessment of PSLOs 1.1-1.5 in the Fall of 2018, Principles of Biology II instructors, Drs. McNeil and Arsov, have implemented a more pro-active approach to teaching in the Spring of 2019, which included a more extensive use of Pearson's MyLab &

Mastering exercise, case studies and online quizzing. Even though the assessment results have not improved significantly yet (Figure 7), the students in Dr. Arsov's class performed better in general than the Fall 2018 cohort. The PSLOs 1.1-1.5 will be reassessed in 2022.

VII. **Synopsis of assessment plan for upcoming academic year**: Using the *5-year plan* and this year's findings, identify program goals and program level student learning outcomes the program will assess in the next academic year and provide rationale.

The following Goal/PSLOs will be assessed in 2019-2020.

Year 2: 2019-2020
Goal 2
Students understand and are able to apply the scientific method.

PSLO 2.1
Students will be able to articulate their hypothesis or question.
Bio 201.
Bio 300s. Oral Presentations

Seminar 486-489.

PSLO 2.2
Students will be able to make reasonable predictions based on a hypothesis or model.
Bio 300s
Bio 400s Lab Report

PSLO 2.3
Students will be able to explain and/or propose an experiment with appropriate controls to test a hypothesis or model.
Bio 201
Bio 300s
Seminar 486-489 Oral Presentations

PSLO 2.4
Students will be able to relate the results of an experiment to their hypothesis and prediction.
Bio 300s
Bio 400s. Lab Report

VIII. **(Optional): Other Activities/Accomplishments:** Describe other program assessment activities related to student learning for this academic year.

Other activities this academic year include fine tuning of our program goals and learning outcomes as well as further refinement of our curriculum map and new ideas how to "close the loop".